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Holocene global geomagnetic field reconstruction based on archeomagnetic data: Assessing error sources and uncertainties

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Using a Bayesian inversion technique, which minimizes the total variational power at the core-mantle boundary under data constraints, several spherical harmonic geomagnetic field models up to degree five are established for the Holocene period covering the last 5000 years. These models are based on different collections of archeomagnetic data and historic observations. Using a bootstrap type statistical analysis the influence of data quality upon the reconstruction of the Gauss coefficients is analyzed. In particular, the influences of uncertainties in ages, magnetic field vectors as well as spatial and temporal distribution are investigated. Besides Gaussian data scatter, also the influence of systematic measurement bias is discussed.

The first step in field reconstruction is the selection of data based on various quality parameters. It is shown that this data selection significantly affects the resulting characteristics of the model. The analysis confirms that age uncertainties can lead to a significant masking of short term field variations. The enormous spread in archeointensity and related ages uncertainties obfuscates underlying magnetic field variations completely for some regions. Including only the most trustworthy data into the inversion reduces the scatter in regional data and, most importantly, the possible bias. However, it also reduces temporal and spatial data distribution significantly. The analysis suggests regions and time intervals for which a re-evaluation of existing data, or an extension of the existing data base is of particular importance in order to enhance the validity and reduce the uncertainty range of a global field model.